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**PCT/DE 04/002424(WO 2004/0044684)  
filed November 02, 2004**

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Date: June 30 2006

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## **Plastic Coating of the End-Inner Area of a Cap**

The invention relates to a method for forming compound layers in a sealing cap comprised of substantially a metal material. Such sealing caps, also referred to as "caps", are used for sealing containers, in particular glass containers, by welding, the upper front end portion of which is provided with seams radially outwards, each of which extending in a tilted manner and being restricted in the perimeter, in order to allow to convert a rotational motion of the "cap" into an axial motion for sealing the container with the described cap and for removing the cap. Thus, the caps are used for the repeated sealing of a container.

The invention relates to a method for manufacturing such a sealing cap, in particular to the fabrication of the compound layer in the peripheral or edge area of the cap, wherein the compound layer forms a seal with the front end of the container and also acts as a mechanical closure at the lateral periphery of the upper end portion of the container. Hence, this area has the double function of sealing and closing such that this area is to be referred to as a sealing and closing or tightening area of the cap (radially outward of a cap level or panel).

The invention also relates to the cap formed by the method (cap, claim 14), which comprises the cap level and the edge area, referred to as "panel area" and "edge area". These areas blend together via transfer zone, which is to be referred to as cap level edge area.

The invention finally relates to a form mould for positioning and forming an applied compound (as a pre-form) in the cap edge area {claim 20}.

A wide variety of caps is known in the art. One type of cap to be mentioned here is the PT cap as described in EP-B 844 972 (Taber, White Cap), cf. column 1, paragraphs [03], [04], which are here incorporated for the explaining of PT caps. These caps are provided with a compound at the edge area or periphery, which provides for a tightening or closing function and for a sealing function. An axial portion of the compound serves for tightening or closing by an axial pressure, wherein the screw cams of the container to be sealed penetrate the compound, resulting in a mechanical locking, which may be disengaged during use by a rotation only. The "P" represents the axial pressing or closing (P-closing) and the "T" represents the rotational opening (T-opening), cf., claim 14, preamble.

For manufacturing such caps two basically distinct techniques for applying the compound are used. The "lining compound" technique and the "moulded compound" technique, which are explained with reference to figures 1 and 2, alternatively a mixture may be used, as described in **US-B 5,686,040** (Taber, White Cap), cf., the abstract. In the latter reference the application of the sealing material is performed by means of a nozzle in the form of stripes along the perimeter, which corresponds to the lining technique. Additionally, in this method an imprint technique is used for changing the position and the shape of the applied compound while it is in a deformable state, which corresponds to the moulded-compound technique. Two types of caps may be distinguished among the described caps, that is, caps having a closed "channel" in their periphery or edge area, wherein the channel comprises a substantially flat bottom, cf., EP-B 844 972, fig 29, and caps having, in the cross section, a wedge shaped channel in the circumference, cf., **US-B 5,413,234** (Hekal), cover sheet, upper figure and associated abstract.

It is an object of the invention to provide a cap having a sealing behavior identical to conventional systems, wherein the amount of compound used is to be reduced in order to reduce costs. In particular, present and future requirements imposed by the sealing of containers to be filled with foods should be met; moreover, within the concept for meeting these requirements a new type of application technique should not be introduced, which may cause additional costs; rather, known methods appropriately to be adapted should be used. The purpose of the invention is to use the conventional technique as much as possible in order to transit to the novel method, cap and moulds as smoothly as possible, while at the same time providing the previously described features of the new cap.

The object is solved by a method, in which two layers of compound are applied in the edge area {claim 1, claim 14}. The two layers of compound are preferably two different types of compound {claim 19, claim 1}, wherein the difference may be of chemical nature or may relate to physical properties. One of the compounds may be an inexpensive one and its food compatibility does not need to be very pronounced, when the compound is used in the radial outward direction with a great distance in the closure area of the sealing and closing area. The second compound may have a higher quality and may thus be more expensive, but it is used in its radial extension in a restricted form, that is, in an area forming a seal with the container at its front end, wherein the second compound may be in contact with the food with its radial inner rim in the sealed state.

The radially inner compound is enhanced with respect to its food compatibility, is, however, reduced in amount, while the compound located radially more outwardly may be optimised with respect to its mechanical strength without having to provide the feature of the food compatibility. This does not exclude that both compounds are of the same chemical and physical nature, however, they will be applied via two different methods to the edge area of the cap in order to cause an interface therebetween, which allows to recognize that a cap {claim 14} formed according to the method {claim 1} is provided with two different compound layers, even though they may be comprised of the same compound material.

With respect to the two methods on the one hand, the previously described method "moulded compound" is used (for the compound located farther radially outwardly), and the lining method (as previously described) is used for the layer of compound located radially further inwardly. Hereby, an overlap zone is created between these two subsequently applied compounds, which causes the above-mentioned intermediate layer, which may be identified in the cross section upon an analysis. Preferably, the compound on the outer edge area with an axially extending tapering more expanded compared to the compound located radially more inwardly, which provides for the front side sealing with the front end of the container.

By referring to the compounds as a first compound and a second compound {claim 1} no ordering is intended, in which these compound layers are applied to the edge area of the cap as a layer (levels). It is only intended to distinguish that the first compound is applied by a first method and the second compound is applied by a second method, wherein both methods are explained.

The order of these methods may be changed. First the layer located in the apron area may be applied. On the other hand, the compound layer located radially more inwardly may be applied first, which is applied according to the lining method. According to the sequence of the methods used there is an overlap zone, in which both compounds overlap and which is preferably located near the circumferential groove {claim 14, feature (a)}. The two methods may also be described such that the radially outer layer does not extend (or does substantially not extend) beyond the inner radial end of the circumferential groove {claim 14, feature (a)}. Alternatively/cumulatively, the compound layer located radially more inwardly may not extend further radially outwardly than the radially outer end of the circumferential groove or the "channel" in the cap {claim 14, feature (b)}.

Furthermore, alternatively/cumulatively the two layers may be distinguished such that one layer extends in a substantially radial manner and the other layer extends in a substantially axial manner, wherein, however, both layers have a given thickness that is adapted to the respective purpose. The substantially radially disposed layer is adapted to the front end sealing of the container. The substantially axially disposed layer is provided for the closing zone so as to cooperate with the screw seams of the container. Both layers together form the sealing and closing zone located at the edge area, which may not necessarily occupy the entire edge area of the cap.

Provided between the edge area and the panel area of the cap (the cap level) is an intermediate zone, which extends radially within the circumferential groove or channel. The compound layer located radially more inwardly does practically no, and preferably not at all, extend into this area so that as less a contact as possible is accomplished with respect to the food sealed in the interior of the container.

The three sub areas of the described sealing and closing zone in the edge area of the cap may be oriented such that they may be referred to as "area 1", "area 2" and "area 3". The first area, "area 1", is in contact with the fill material, thus it is located in the intermediate area (transit zone) between the panel and the edge area. The second area, "area 2", is the sealing area, which mainly acts as a sealing together with the front end of the container. The third area, "area 3", serves for embedding the screw thread and for providing for the mechanical closure and the support, respectively, of the sealed cap, after it has been sealed with an axial pressing in order to be opened by screws in a re-sealable manner.

The compound layers applied by the different application methods occupy different geometrical areas in the edge area, that is, the closing area and the sealing area {claim 1}; an overlap zone {claim 9}. By the specific application of the two compound layers different characteristics in the sealing and closing area may be created. Each section of this sealing and closing zone may be given dedicated characteristics. The application of the compounds by the combined use of the Moulded Compound and the Lining Compound serves for the precise alignment of the respective used compound with respect its specific purpose at its specific location within the edge area of the cap {claim 8}.

The lining method is accomplished by injection moulding of a compound, wherein the cap is rotating. After introduction of the compound into a circumferential channel a mechanical post-forming by means of a ring imprint die may be omitted {claim 2}. A rotation of the cap takes place during or after the application inducing a displacement

effect, wherein the still flow-like just introduced compound is moved radially outwardly, however only in a restricted amount {claim 1; claim 14, feature (b)}. This radial displacement may already begin during the injection.

The compound pre-form also applied by the lining method that is located radially more outwardly compared to the above-described lining-application is deformed after application {claim 3} by an imprint die, which is a ring or annular die {claim 20}. This second compound is first positioned (during the application by a rotation of the cap), does not exhibit a rotation deformation but a die induced deformation, which extends only into a portion of the sealing and closing zone that comprises at least the closing zone of the cap. This is a substantially axially extending deformation including moderate amounts of a radial deformation when the circumferential channel of the metal shell (the cap raw form) is concerned {claim 15}. As far as the compound extends into the sealing zone {claim 4}, this compound layer is covered by a subsequent lining deformation in the form of rotative application and rotative displacement such that the surface of the sealing zone is formed in the edge area of the cap by the compound applied as the second compound. The resulting overlap zone is then configured such that in axial direction towards to the closing area of the container provided at the front side only the second compound is exposed, while the underlying first compound is covered.

When the order of the methods used is inverted, the second compound geometrically deformed by the moulded compound method does not extend into the sealing zone, but remains in the closing area {claim 3, claim 14, feature (a) and (c)}.

When the compound applied as the second compound also extends into the sealing zone {claim 4}, it is covered there - as previously explained - by the first compound applied afterwards, which is displaced, starting from the radial inner region, by the rotation of the cap.

In other words, the displacement of the two compounds after their respective application in the form of a circumferentially extending toroidal compound string is restricted {claim 5}. This restriction may be effected by a ring-like barrier in such a manner that this barrier is located in the cap groove {claim 7, claim 25, claim 27}, or is provided by the annular die form {claim 6}, at the front side of which the barrier is provided as a front side protrusion, like a fin, or is provided as an outer peripheral relatively sharp edge.

During the respective deforming displacement of the second compound either the die or the annular barrier in the circumferential groove of the cap acts as a resistance at a predefined position for the radially inwardly directed flow of the deformed compound and restricts this flow {claim 5}. The flow therefore extends at most into the sealing zone with respect to the point in time of the end of the flow of the second compound caused by the annular die. This inner border does not mean that this inner flow should always extend to the inner end, but it may be completed earlier, for instance by the radially widely outwards located edge of the annular die {claim 21}, the flow may also be ended in a later stage when the flow is restricted by the radially inwardly located edge of the circumferential groove. Intermediate positions are possible {claim 6, 7}, caused by the axial protrusion at the annular die {claim 22} or an annular barrier in the circumferential groove of the cap, as a circumferential fin having a height that is less than a depth of the circumferential groove. Preferably, this barrier is used within the circumferential groove for such a shape of the circumferential groove which has a substantially flat horizontally disposed bottom. In an alternative groove, which substantially extends in wedge-like manner without a flat bottom the circumferential barrier for the radial inward displacement of the second compound (by the die induced deformation) given or barred by the shape and geometry of the annular die.

Further improvements for the structure, the adhesion and also for the other properties of the double layer are obtained by using an additional die that may also provide the compound layer applied radially more inwardly, that is, the first compound, with a pressure force {claim 10}. This application of the pressure force may occur prior to or after the application of the second compound. Upon the axial pressure a more uniform axial height is obtained. The first compound that is displaced radially outwardly in a too intensive manner caused by rotation, thereby resulting in a too large height (thickness), is pushed back to a substantially uniform axial height or thickness, resulting in a two-fold advantage. Created bubbles are reduced and the adhesion between the two compound layers or the adhesion of the first compound layer to the tin cap in the circumferential groove is enhanced. The improvement with respect to the reduction of bubbles and the adhesion occurs in the circumferential stripe forms. A border line of the compound located radially more inwardly, that is, the radially outermost border line is enhanced in view of its non-uniformity ("tail formation") and may be made more uniform by the additional effect of the die {claim 11}.

The second die has a different configuration compared to that die that is used for the radial displacement of the radially outer compound {claim 20}. The step of the rotating displacement by centrifugal force for the radially inner compound may be reduced in strength due to the die induced deformation. A double layer of

compound material is created, which is free of bubbles, exhibits a good adhesion and lacks abrupt, protruding transitions, thus the double layer has good-quality transitions. This method step providing for a post-shaping or post-forming complements the lining method by an additional process step. This process step acts upon the still flowable first compound for reducing bubbles or improving the adhesion {claim 12}, in a stripe area near the outer edge of the radially inner compound layer.

If the combined groove is used {claim 7}, the additional die enables the formation of a channel at its front end {claim 13}, which is bordered by a fin located radially outwards {claim 24}. A circumferential recess or clearance provides for the formation of the channel in the pressed state in order to receive and radially restrict the compound already applied and displaced by centrifugal force. At the same time the compound is pressed into contact, the adhesion is enhanced and within the smaller narrower groove the condition for an improved separation of surfaces within the overlap zone is achieved. Here the smaller groove has a different function in the context of the larger (broader) groove compared to the same groove during the application method in which the compound located radially more outwardly is applied first {claim 7}. The smaller annular groove within the larger circumferential groove at least hinders the further radial displacement, even though it may not prevent the displacement entirely. In the sense of an existing barrier or resistance it acts, depending on the applied amount and the rounds per minute selected, more or less as a "resistance" with respect to the outward displacement of the still flowable compound located radially inwards. It should be appreciated that this barrier results applying the compound located radially more outwardly in a subsequent step and displacing it by a die in a deforming manner {claim 13, claim 20}.

Based on the two combined application methods the extension of the compounds into the "area 1" (in the panel edge area) may significantly be reduced or even completely avoided in order to reduce the contact with the fill material to a minimum.

Substantially, the area used for sealing is occupied by the high-quality compound with an area provided for the sealing, representing the "area 2". The "area 3" for creating the mechanical support is not or only insignificantly covered by the high-quality compound. Geometric position and spatial extension of the two compound layers, consisting of the first and the second compounds, respectively, which may preferably be different, are thus predetermined in a precise manner with respect to their respective usability and dedication {claim 8}. This predetermination of the geometric extension is especially advantageous for PT caps, which need the compound in the apron region of the cap for closure purposes. Any forms of the circumferential grooves

may be used in the area of the apron and the cap level, including a rounded bottom {claim 18}, including a flat bottom {claim 17}, or including an additional fin in the flat bottom. The amount of high-quality compound to be applied, which has to be food compatible, is restricted to region of the "area 2". The "area 1" is substantially free of the sealing agent and the "area 3" may, for mechanical support, be occupied by a compound of lower quality.

The precise geometry and the extension of the high-quality compound in the "area 2" may be adjusted by the position of the application of the toroidal circumferentially extending compound pre-form, the speed of the rotation of the cap and the amount or mass of the firstly applied compounds. The shape and position of the second compound is determined by the shape and geometry of the die that causes the displacement and the deformation of this compound after application. During the die induced deformation this method is divided into two sections, that is, the introduction or application of the pre-form of the compound and the die induced deformation. During the application of the first compound by the lining method these two method steps may occur concurrently or overlap by rotational application and rotational displacement such that the rotation speed during application may concurrently cause a radial displacement.

Hereby, it is to take into consideration that the cap having its apron facing upwardly is covered by the compounds and the applied compounds are also deformed in this orientation of the cap, while the cap is used after the fabrication and during the normal usage in an inverted state, wherein the compound layers face axially downwards.

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Illustrative examples explain and complete the invention in the sense of "embodiments".

Figure 1a,

Figure 1b illustrate the application of a compound layer C\* by a method according to "moulded compound", in two steps, the application of the compound as a pre-form C and the mechanical deformation by a die 40\*.

Figure 2a,

Figure 2b illustrate the application of a compound pre-form C' by a method according to "lined compound", including the application of the compound and the displacement C" by rotation, in this example without using a die\*.

Figure 3a illustrates three different sections or areas "area 1", "area 2" and "area 3" in a cap 1. Only an edge area of this cap is shown, with an area of the radially outer end of the cap level 3\*, which should no longer be considered herein. The cap 1 is occupied in its edge area 40 by the compound C by a die acting from bottom to top, the compound extending into all three areas "area 1", "area 2" and "area 3".

Figure 3b illustrates the completed cap after the fabrication according to Figure 3a, positioned on a container 90, whose upper edge area is provided with radially outwardly protruding screw seams engaging into the compound C in the "area 3". At the front side the container 90 is sealed with the "area 2", while "area 1" including its compound extends radially inwardly with access to the food within the container that is not shown.

Figure 4 illustrates a cap in two perspective views from the interior and the outside as an embodiment.

Figure 5a illustrates the edge area R of a cap in an axial section including the three enclosed areas, "area 1", "area 2", "area 3", and a compound applied in a circumferential groove.

Figure 5b illustrates the effect of a die 40 for forming a second compound B at the apron region 4 of the cap 1 of figure 5a.

Figure 6a,

Figure 6b illustrate the application of the first compound, followed by applying pressure by another die 50, and a state of the fabrication method of the cap, in which the second compound located B radially more outwardly is deformed in a displacing manner by the die 40 as shown in figure 5b.

Figure 7a depicts an alternative cap 1, for example the cap of figure 4, including a circumferential groove 20 having a substantially horizontal bottom and a compound layer A formed therein.

Figure 7b depicts the same cap of figure 7a in a further manufacturing step including a further second compound layer applied and deformed in a displacing manner and located at the axially extending apron 4, with an axially introduced die 40 in its end position for the deformation in a displacing manner.

Figure 8a,

Figure 8b show a manufacturing technique similar to that of figures 6a, 6b, except for a different shape of the circumferential groove.

Figure 9a shows a cap having a circumferential groove 21 having a rounded groove bottom 21a, wherein a die 40 having a different front side configuration compared to figure 6b engages in the cap in the edge area.

Figure 9b illustrates the same cap of figure 9a after another method step having an additional layer of the compound A within area 2.

Figure 10a illustrates a further manufacturing method including the application of the radially outer compound B as a first layer according to figure 9a.

Figure 10b is a later step of the manufacturing method, in which the radially inner compound A is planarized with another die 51.

Figure 11a illustrates a cap 1 similar to that of figure 7a, including a die 40 moved axially inwardly for forming a compound layer based on the compound B, and a front side circumferential fin configuration of the die 40.

Figure 11b illustrates a further manufacturing step of the cap of figure 11a, with which the second compound layer of the compound A is applied.

Figure 12a,

Figure 12b illustrates a manufacturing method according to figures 11a, 11b, except for an additional die induced deformation by die 51 with axial pressure applied to the radially inner layer of the compound A.

Figure 13a,

Figure 13b illustrate a cap 1 similar to that of figure 4 with an additionally applied circumferential fin 20a, which is smaller in width and height (depth) as the circumferential groove 20. The radially inner compound is applied first and subsequently displacement in a deforming manner by centrifugal force. In the figure 13b a later method step is shown, in which the radially outer compound B is deformed by a die 40, wherein an overlap zone is formed in the region of the smaller circumferential fin 20a.

Figure 14a,

Figure 14b illustrate two method steps of a method for manufacturing of a cap 1 having two layers of compound and including two die induced deformations.

Figure 15a,

Figure 15b illustrates a method including two die induced deformations, wherein cap has a shape as shown in figures 13a, 13b. Here, first the outer compound B is applied, then the inner compound is applied and a second die induced deformation by the die 51 with respect to the compound located radially more inwardly is performed.

Figure 16a illustrates the cap 1 similar to that of figure 4, with an additionally applied circumferential fin 20a in the circumferential groove 20. At the edge area of the cap a die engages, which forms the first compound layer based on the compound B.

Figure 16b illustrates a further manufacturing step after the one of figure 16a, with which the compound layer of the compound A is applied to the area 2.

Figure 17 is enlarged view of the circumferential groove 21 of figure 5b. It should be shown the barring effect of the outer radial edge that is formed relatively sharp.

Figure 18 illustrates an enlarged view of figure 13b with the circumferential groove 20, 20a as a combined groove 22. The engaging die 40 has a front side protrusion 42', which is thinner compared to a fin and which protrudes in a wedge-like manner, sufficient to apply a barring effect to the outer compound B put under axial pressure and to prevent an increased radial inward displacement of the compound.

In the figures first the operation of the two mentioned methods of the "moulded compound" and the "lined compound" should be described on the basis of the figures 1 (figures 1a, 1b) and the figures 2 (figure 2a, 2a). Figures 3b and 3a schematically show a cap according to the prior art and a manufacturing method with the moulded compound technique for the fabrication of the cap of figure 3b. Before the fabrication method the state of the engagement of s die 40 is illustrated, which has deformed the compound layer of figure 1a in such a way as is schematically shown figure 1b, however, especially with respect to the shape of the cap in the edge area. This cap is then attached to the glass container, by axially pressing, while the cap may be removed and again attached from/to this glass container by a threaded motion. This illustrates figure 3b (press-twist).

First it should be appreciated that the axial sections shown in the figures illustrate the edge area of a cap, which additionally comprises a panel area that is here shown in a non-recessed manner, and a narrow transition area, indicated as panel edge area 3a, provided between the latter areas. The edge area R is the area that has the closing function and the sealing function with respect to the container 90 to be sealed. The

panel area hides the opening of the container mostly provided as wide-neck container, which is schematically indicated in figure 3b and otherwise not detailed herein. In this respect it is to be noted that a die motion and an application or introduction motion of compound is typically applied axially from the upper part, that is, the apron region of the cap is protruding upwardly and the panel area is horizontally oriented when the respective method steps are applied. During use the cap is then inverted and its apron regions faces axially downwards. In order to facilitate the comparison of the method, the method steps and the associated resulting compound layers in a more convenient manner, the axial die induced deformations shown in the figures are also shown as engaging from below, although in practice they engage from the upper side during the method stages when the cap is inverted. When the numerals, beginning with figure 4, are not repeated on a regular basis, identical components and sections of the cap are referred to. As far as the prior art is described in figures 1 and 2, the same reference numerals are used, except for "\*". The compound is commonly indicated as B.

A first method according to figures 1 is the application or introduction of a toroid-shaped compound C into the edge area of a (schematically depicted) cap 1\* by means of a nozzle, radially outside and, in the configuration depicted, axially slightly below a circumferential groove 2\*, during a rotational motion  $\omega 1$ . This radial application is predetermined by the application of the toroid-shaped compound raw form C (pre-form) to the sidewall 4\*. In reality, the application is inverse, with an application from axially above, with a flatly oriented cap level 3\*, so that the raw structure C is located axially slightly above the groove 2\*. In the following it is always the orientation described that is depicted, while bearing in mind the previously given explanation that during the manufacturing process the situation is axially inverted.

In a second step according to figure 1b a die 40\* is introduced into the edge area R of the cap 1\* from axially below (in reality: from axially above), in the direction P1, wherein the cap is shown to be lifted in the direction P1, actually the cap is recessed, by applying a pressure force. Hereby, the compound C is changed in its shape and in the radial inward direction and in the radial inward direction  $r1$  and in axial downward direction  $z1$  displaced in a deforming manner. In this way a layer C\* of a compound is formed, which extends radially inwardly also across the inner periphery of the circumferential groove 2\*, which is not yet illustrated here, upon an increasing pressure by the die configured as shown here, which allows an inward motion of the compound also via the inner edge of the groove. The completed cap comprises after the removal of the die 40\* a sealing and closing layer provided by "moulded compound", which causes the cooperation in the axial area with tilted cam sections, which are not shown here which are, however, illustrated in figure 3b. At the front end

the layer provided in the circumferential groove 2\* results in a sealing, as shown in figure 3b with respect to the front side of the upper section of the glass container 90.

A second alternative method of applying a compound is illustrated in figures 2. Here, radially more inwardly a raw form of the compound C' is injected at an inner edge of the annular groove 2\*, while the cap is rotating with speed  $\omega_1$ . Also in this case the axial orientation is depicted in an inverted manner, the raw form C' is introduced into the groove 2\* from above. During the rotation with  $\omega_1$  or during a different rotation  $\omega_2$  in a later stage the compound is displaced substantially within the groove 2\* along the direction r2, with a substantially radial displacement direction, or with a minor axial component, in order to create a sealing layer C'' that is configured to cooperate in a sealing manner with the front end of the container 90, as is shown in figure 3b. By a second application of a toroid-like compound material at the radial outer end of the annular groove after the second depicted step of figure 2b, also the apron region 4\* may receive a sealing layer corresponding to the sealing layer of figure 1b, by also rotating the cap 1\*.

The deformation or change of shape according to figures 1a, 1b with respect to a real geometry of a cap 1 is illustrated in figure 3a.

Here, three areas, area 1, area 2 and area 3 are given, which form upon moving the die 40\*. The same areas are illustrated in figure 3b with respect to the cap when attached to the container 90. Area 1 is exposed within the inner edge of the glass container. Area 2 provides for the axial sealing function and area 3 provides for a mechanical support function at the seams of the glass container. A lower role section 5\* connects to the apron area 4\*.

Area 2 extends in radial and partially in axial direction. Area 3 extends substantially in axial direction only. Area 1 substantially extends in radial direction only. All areas 1, 2 and 3 described before are formed from the same compound during the same manufacturing sequence that corresponds to that figure 1b. For this purpose, the die 40 has tilted contours, which are partly provided with radial grooves and which enable the penetration of the compound into the inner area indicated as area 1. In each of the three areas circumferential structures of compound are formed for different purposes. Due to the contact with food in the area 1 the compound must be food compatible and also requires, due to its presents in area 2 and area 3 the entire functionally required extension in the edge area of the cap. This compound is denoted as C.

One example of the cap according to figure 4 is based on the same geometries of the metal shells of the cap, wherein the edge area R is separately illustrated. The cap level 3 defines the panel area, which should not be explained in more detail further on. The panel edge area 3a connects to the edge area R, that is, the edge area includes an edge section of the panel, as is evident in figure 3b when referring to area 1. The apron section 4 substantially extends in the axial direction, is slightly contoured in a geometrical manner and ends in a lower in-roll section 5, which ends in the illustration of figure 4 with a sharp lower edge, which may according to figure 3a or 3b be provided with an in-roll 5 (or 5\*), which is provided at the axially lower end of area 3.

Between the panel edge area 3a and the apron section 4 is provided circumferential groove 2, which is schematically indicated. In the following figures different geometries of this circumferential groove 2 are denoted as 20 and 21, respectively. The view into the interior of the cap according to the left hand illustration of figure 4 illustrates two geometrically differently positioned and geometrically differently configured compound layers A and B, which are applied or introduced into the cap according to methods still to be described. These compound layers A, B are located in the edge area R and act there as a seal and a closure. They form a sealing and closing zone 10, the individual sections 10D and 10V of which are assigned to the different functions. Zone 10D serves for sealing, at the front side of the top side of the container 90, as is shown in figure 3b. This layer of compound A substantially extends in radial direction, but has a certain strength in axial direction. The layer of compound B substantially extending in axial direction is the closing area 10V. This layer extends into area 3. It serves for closing, together with the outwardly facing seams at the upper section of the container 90.

A plurality of manufacturing methods are explained in various pairs of figures. The figures 5a, 5b, and the figures 7a, 7b respectively, depict the same method, except for two different types of circumferential groove 20, 21 at a cap 1 according to figure 1 in the edge area R. Similarly, the figures 9 and the figures 11 are further embodiments of the same method, wherein the two different geometries of the circumferential groove 20, 21 make the difference, resulting, respectively in a different formation of the compound layers A and B. In figures 16 a new type of circumferential groove 22 is used in a method that is similar to that of figures 9 and 11.

In the above-mentioned pairs of figures not all of the process steps are shown, instead only two process steps are illustrated that indicate the difference if the described methods with respect to the prior art.

According to figure 5a a pre-form of a compound A is first applied according to the approach of figure 2 at the radial inner end of the groove 21, which is accomplished by rotating the sealing cap 1 (cap). The cap rests on a carrier with its apron 4 facing upwardly. Already during the rotation or separately thereafter with a step of separate rotation the deformation of the toroid-shaped injected in compound B of the pre-form corresponding to the form according to figure 5a is generated. It substantially occupies the entire groove geometry 21. The groove geometry 21 is configured such that it comprises in the axial section a rounded bottom section 21a and an inclined section 21b, which is tilted with respect to the horizontal and to the axial directions. The rounded bottom has a radius of curvature that is very narrow and the orientation of the curvature is perpendicular with respect to the circumferential direction and with respect to the axial direction. The inclined section 21b is provided radially within the curved section 21a. This form will be mapped into a compound layer A distributed by a rotation  $\omega_1$  and  $\omega_2$ . In a later process step, which follows that of figure 5a, again a toroid-form of a further compound B is applied, which is located radially more outwardly, corresponding to figures 1. In a die induced deformation according to figure 5b this form or shape is changed into that illustrated form of the compound B, wherein the compound performs a flow and experiences substantially an axial change and is flattened. A compound layer B results substantially in area 3, but also extending into area 2, wherein the compound layer B overlaps with the compound layer A, applied first in area 2. The overlapped occurs within the groove 21.

The die geometry of the die 40 having a radially outer edge 41 restricts the flow motion of the compound layer D in radial direction so that the layer does not extend far but only slightly into the area 2 upon end of the motion and the pressure induced by the die 40.

After the removal of the die 40 the compound layer geometry is determined, that is, a radially more inwardly located first layer, which was applied first and which is the compound layer A, and a radially farther outwardly located layer as the compound layer be, which extends substantially axially and covers the apron area 4 in the area 3. Both layers have different functions, the former one has a sealing function and the latter layer has a mechanical support function.

The "3 areas" (areas or sections), area 1 radially within the outer edge zone 3a of the cap level 3, area 2 as sealing area 10D and area 3 at the apron 4, within the closing area 10V are configured as previously described. As can be seen in the completed cap according to figure 5b area 1 comprises only insignificant amounts of sealing agent, possibly a very small amount at the edge area, essentially without sealing

layer, compared to the sealing end section of figure 3b which extends far into the interior. Both layers A and B do not have a constant thickness along their respective main extension direction, that is, the compound layer A in the radial direction by means of the wedge-shaped groove having the two sections 21, 21b, and the axial layer B, resulting from the shape and geometry of the annular recess 46 of the die 40, which substantially extends perpendicularly to the front surface, as is previously described, and which contacts the first sealing layer A during the press operation. Between both layers, the front surface and the inner wall of the recess 46 a substantially annularly extending moderately sharp knee is created, which may also be referred to as a barrier, as substantially more efficient formation of the compound in radial direction is blocked. Also the compound B has in its axial main direction a varying thickness (along the radial direction). Both main extension directions are substantially larger than the respective sub extension directions belonging to the same layer in view of the respective thickness: The radial thickness at the axial compound layer B, and the axial thickness at the radial compound layer A.

It is to be noted that the die 40 comprises a body section 40a as a structural component, which is substantially broader compared to the front section, which is configured narrower and which supports the barrier edge or ridge 41. Between these two differently dimensioned sections 40a and front edge of the die 40 a surface 45 extends radially inwardly, which substantially continuously changes its slope for a thickness change of the die 40. The different areas of the die have the different functions as previously described. The annular recess 46 serves for the change with respect to a deformation and displacement of the pre-form of the radially outer compound B; the front side is used for abutting and its peripheral edge serves as a barrier for a further expansion.

In a comparative process sequence the compound layer structure according to figures 7a, 7b may be applied, wherein the circumferential groove 20 is provided with a flat bottom substantially extending in the horizontal direction. The correspondingly illustrated structure of the first compound layer A applied according the lining method of figure 2 is substantially flat, ring-shaped and covers the essential portion of the area 2. In a later process step the second compound layer B is formed by the die 40 after application, also in this case substantially axially extending including an overlap area that is located in the channel 20 of area 2. The radial inward flow motion of the deforming compound of the layer B is restricted by the radially outer upper edge 41 of the die 40.

The die 40 comprises on its outer side a recess 46 that extends annularly and determines the shape of the compound layer B. At its inner side the die is provided with a continuously extending surface 45, which leads from a narrow front side to a thicker body area 40a of the die. The narrow front area, at the outer edge area of which also the edge 41 is provided, is narrower compared to the circumferential groove 21 of figure 5b. A radial inner edge 43 of the front side of the die 40 is formed without grooves and roundings, since it does not need to have the capability for passing radially displaced compound to the area 1. Rather, this flow of compound B is already hindered, decelerated or blocked by the edge 41 with respect to the radial inward motion so that the inner edge 43 of the front side of the die is freely configurable, preferably it rests on the compound of the layer A in a sealing manner, without providing radial grooves, channels or other flow zones for a displacement of the compound layer B at the front side of the die 40, which extends beyond the inner end of the groove 20.

In the edge area R a zone 10 is provided as a sealing and closing area, which comprises two sections, that is, a substantially axially extending zone 10V and a substantially radially extending zone 10D. This is adjacent to the panel edge area 3a in the inner side, which in turn surrounds the panel area 3. Within the sealing zone 10D that corresponds to area 2 the compound A according to figures 5a and 7a is provided. In both embodiments the area 1 in the panel edge area is free of a sealing layer. Area 3 substantially corresponds to the closing zone 10V of the sealing and closing zone 10.

During the application of the compound A according to the figures 5a, 7a that is preferably configured as an injection and during the later figures with respect to the lining process, the compound is applied and formed without a mechanical post-forming by means of a further annular die. Also the annular die 40 does not cause a flow motion in the radial inward direction and no flow motion in the radial outward direction with respect to the first compound of the layer A, rather, the annular die 40 results in a deformation of the substantially axially extending layer of the compound B, which is illustrated in figures 5b, 7b. Also during this part of the process the application is preferably performed by injecting a compound radially more outwardly compared to the situation of the figures 1a, 2a, of the pairs of figures 1 and 2, when this process is applied to the pairs of figures 5 and 7.

In the figures 5b and 7b the second applied layer of the compound B does not extend further than the sealing zone of area 2, which is also denoted 10D after the end of the flow caused by the annular die 40. According to figures 7b and 5b the compound layer

B extends with its increased portion (thickness) into the groove area 20, 21, in which both compound layers overlap. Thus, a short axial part of the compound layer B only slightly extends into the area 2, the same holds true for the radial direction and the thickness.

The extension in the thickness direction of the first layer of compound A and the second layer of compound B is not constant, as is in particular illustrated in figure 5b, and also in figure 7b in the overlap area near the flow hindering edge 41 of the die 40, in the form of a circumferential borderline.

Seen from another point, the first applied compound A extends no further in the radial outward direction as a layer than the circumferential groove 21, thus, it does not extend into area 3 but is tightly restricted to area 2 as a closing zone 10D of the closing and sealing zone 10. The orientation substantially in axial direction and substantially in radial direction may be described as L-shaped with respect to the axial section according to figures 5b and 7b. In three dimensions this corresponds to a cylindrical shape of the compound B and to a substantially flat ring shape of the compound A. Minor deviations of the this basic geometry are illustrated in the further embodiments, in which the overlap zone is provided more pronounced and is located immediately next to the groove 20 or 21.

The pairs of figures 9 shows a first application of a compound B after the imprint technique according to figure 1. The die 40 here is configured in the front side in a special manner and includes an axially increasing fin geometry 42, which extends in to the circumferential groove 21 in area 2, when the die reaches its uppermost axial position (in the real process the lower axial end position) at the end of the deforming displacement motion with respect to the compound B. The sealing cap 1 (cap) is further the same, except for the compound layer B being located far in the circumferential groove end extending into the area 2 in the axial direction farther as for example shown in figure 5b. The flow radially inwardly is restricted by the fin 42 at the die. The other intermediate steps of the process, in particular the injection of the compound near the apron 4, are the same as previously described.

The fin 42 is provided without sharp edges end is rounded. The entire front side of the die 40 opposite the body 40a has a continuously extending surface. In this way, the tin at the inner side will not be damaged and additionally a gentle form of the L-shaped leg of the compound layer B is formed, at which a layer A is applied according to the following figure.

An enlarged view of the overlap area with die engagement 40 is shown in figure 17, which is a magnification of figure 7b. The wedge-shaped groove with inclination 21b and radius of curvature 21a shown therein receives the first compound layer A. The second compound layer B comprises an overlap area D extending in the area 2. The engagement of the die illustrates that the barrier edge 41 prevents a further radial expansion into the interior of the flow and forming motion of the compound layer B. The edge 41 transitions into a stripe-like approximately flat front section and becomes a downwardly declined inner section with respect to the inner edge 43, which may be sharp or rounded. The die 40 is with its front ring face narrower than at its body section 40a. Its radially outwardly facing recess 46 reflects the shape or form and flow motion of the compound layer B.

As is evident from the enlarged view the barring zone does not necessarily need to be an exact line but may extend across a certain piece of surface, which may be curved and annular. The entire front side surface of the die 40 is not necessary for this barrier since the wedge-shaped annular opening between lower surface of the layer A and front side surface of the die 40 faces radially the exterior of the inner edge 43.

For obtaining the configuration of figure 9b a process step follows, with which corresponding to figure 2a a pre-form of a compound at a rotation radially within, here in the intermediate area defined by area 1 and area 2, is applied and is changed in position and shape by the rotation  $\omega_1$ . Determined by the shape of the compound B within the circumferential groove 21 a complementary shape or form is obtained for the cap layer of the compound A which, as is evident, forms a substantially horizontally located overlap zone, and which has a lower surface facing the inner side of the cap, which is formed by the compound A having the higher quality. Area 1 is further substantially free of a compound, after the same is displaced to the radial outward direction by the rotational motion  $\omega_2$ .

Both compounds overlap in the circumferential groove 21 radially within area 1 is no compound provided and area 3 is without any extension of the layer of compound A provided with compound B.

In the same order of the die induced deformation of the firstly applied compound B and a deformed compound layer A caused by a rotational motion the figures 11 are to be understood. The difference with respect to figures 9 is the form or shape of the circumferential groove 20 between the panel transition area 3a and the vertical apron 4. Also in this case a circumferential fin 42 having a certain thickness restricts at the front side of the die 40 the flow in the radial inward direction in that it contacts the flat

bottom of the circumferential groove 20 in its uppermost axial position (in reality the actually lowest position). The complement and the remaining filling of the groove defines the second compound layer including the compound A applied according to the lining technique. Also in this embodiment the compounds substantially extend in a perpendicular manner, wherein a deviation in the overlap area with respect to the main extension direction is provided that is, the compound B slightly extends radially, while the compound A is also changed in the thickness direction such that it may be considered as an axial extension. The main extension direction along the axial direction for the compound layer B and along the radial direction for the compound layer A does, however, not change this situation.

The die 40 is configured as previously described, having a gentle inner surface 45, however, the radially outer edge 41' is not as thick and sharply provided as in figures 5b, 7b. There function is performed by the upwardly protruding annular fin 42 such that the outer edge 41' maybe configured more gently and significantly rounder.

In the embodiment according to figures 16 the groove 20 according to figure 4 has first a flat bottom, in which a circumferential intermediate groove 20a is applied. This intermediate groove may be applied as a circumferential fin prior to the application of the compound in the cap shall made of metal tin. A combined groove 22 results that is from 2 oppositely directed concentric grooves 20, 20a, that is a so-called "double ring channel" on both sides of the intermediate groove 20a having the lower depth and the smaller width.

The intermediate groove has the function of restricting the flow of the first compound layer B applied by the moulded compound technique, wherein the first compound layer B extends substantially axially and as the only layer into "area 3" and also significantly into "area 2" while being radially restricted by circumferential groove 20a.

The circumferential groove 20a is provided with a height (depth) which is lower than the height (depth) of the circumferential groove 20 with respect to the distance between the cap level 3 and the flat bottom geometry of the circumferential groove 20. Accordingly the radially more inwardly positioned compound layer A according to the lining technique described in figure 2 may extend significantly into "area 2" and beyond the circumferential area in order to form the overlap zone with compound layer B radially outwardly located in the groove 20. Also in this case the entire area of the compound A is occupied, which cooperates in the closed state according to figure 3b with the front side of the container edge.

The comparison of the different pairs of figures and of the different process results by using the two subsequently applied compound layers demonstrates that the overlap zone near the groove 20 or 21 is configured differently, which does not change anything on the basic distinction of the axial extension and the radial extension of the respective compound layer relative to its extension in the thickness direction oriented perpendicularly. The compound layer B extends more or less into the area 2 as a sealing zone 10D but will in any case be covered by the compound layer A for an increasing extension into this area 2 such that the closure effect with the container is always provided by the high quality compound A. This layer of higher quality extends farther in the radial direction than the extension of the circumferential groove. The longest extension is shown in figure 5b, the lowest extension is shown in the figures 9b or 16b, which is sufficient to provide the sealing function by contacting the container edge alone.

Area 1 is essentially free of compound. In this region no compound is radially pushed inwards by the application. In this way, it may be avoided that the area of the compound comes into contact with the food. Moreover, it may be avoided that the high-quality compound A of the compound layer A extends too far into the radial outward direction and thus is involved in the closing function or such functions of the cap according to PT manner. The costs for this compound may therefore be reduced for superior chemical or physical characteristics. The physical characteristic of the compound B may be changed in that strong expansion of this compound occurs for enabling the closing function. The chemical and physical characteristics may each be precisely adapted to the intended function. The same compound does not need to fulfil several functions in order to perform the required characteristic at the required position along its entire radial and axial extension. The different physical and chemical characteristics may be restricted to the respective required area of the edge area R and, in the present case, to the closing and sealing zone 10, as 10D, 10V.

It should be added that the compound pre-form not illustrated in the pairs of figures 5, 7, 9 and 16 is configured in an annular manner according to the embodiment of figure 1a. Instead, the embodiments are provided with compound B with the same form or shape, which is in figure 1a illustrated as a toroid-shape. This shape does not appear in the figures beginning at figure 5, since they are already illustrated as deformed or changed in shape and displaced by the engagement of the die 40. The pre-forms are in the same shape of an annularly injected pre-form at the apron section 4, which is then cylindrically deformed by the recess 46 with optionally a radially inwardly protruding upper section according to figures 9b, 11b and 16b.

The forming die 40 is clearly recognizable in its engagement position in figures 5b, 7b, 9a, 11a and 16a. It is denoted as 40 and has a body 40a below the lower end of the sealing cap 1 (of the lower rolled-in section 5), and a front section that strongly tapers and is reduced to a portion at the front end that is narrower compared to the width of circumferential groove 20, 21. A cylindrical peripheral recess is denoted as 46. It receives the pre-form (the toroid-shape) of the compound B of the injected state and displaces and deforms the same to form the cylindrical layer which substantially extends in the axial direction only. Opposite to the recess 46 is provided a continuously extending surface 45 which connects a body with the significantly narrower front end.

Due to the configuration to the front section it may be avoided that the compound B is significantly displaced in the radial direction. At as hereby restricted to a maximum possible yet not necessarily occurring displacement which is substantially less compared to the actual displacement as is illustrated in the maximum extension of figure 9b. There, the displacement in the radial direction is about 20% to 30% of the displacement in axial direction. The minimal radial displacement is illustrated in figures 5b and 7b, which is caused by a relatively sharp edge 41 at the radially outer and of the front face, wherein the sharp edge has an angle ranging from 90° to 120°, as shown in figure 17.

The flow barrier by a downwardly protruding circumferential fin 42 is directly located at the front side for the contact-free cooperation with the bottom of the groove 20 or 21 wherein than the radially outer edge 41' is rounded more pronounced compared to the missing fin at the front side of the die 40 according figures 5b, 7b.

The radially inner front end 43 of the forming die 40 may relatively freely designed. The flow of the compound B may not reach this end so that the flow may also not enter the area 1 which is to be maintained free from compound. The flow may also not reach the actual sealing face formed by the compound A so that a radial flow is blocked in a substantial portion of area 2.

The lower (in reality: "upper") remaining section of the annular die, which is not shown in the figures is known from the prior art and may not be explained herein in further detail. It has a support section and a driving mechanism for lifting the die and lowering the same, depending on the operational state. The actuation of the die may be performed mechanically, for instance by hydraulic or pneumatic means. The actuation of the die typically occurs from above, although this is shown in the embodiments for

reasons of comparison with respect to the cap in its closing position in a bottom to top actuating manner.

In the intermediate figures not described so far the pairs of figures 6, 8, 10, 12, 14 and 15 a second die induced deformation step is added, wherein the starting process steps are based on the respective embodiments which are shown on the same page and are described above. For the pairs of figures 13 and 14 only, a separate description follows later on with respect to the usage of the combined groove 22 (shortly: combi groove) in a different radial blocking direction compared to the figures 16 already described.

The additional die 50 used according to figure 6a serves for making the compound layer A more uniform, which has been first applied and displaced and deformed by rotation. In the illustrated wedge-shaped groove 21 including the inclined face 21b and the radius of curvature 21a a significantly flatter lower surface is obtained compared to figure 5a when the first already applied compound layer receives a post-deformation by the pressure via the front side 50b of the die 50. For this purpose the die 50 itself has a lower (in reality: upper) body 50a, an outer surface 50c, which is substantially as a cylinder actually oriented and with a distance located to the apron 4, and an inner axially backwardly displaced stripe configuration 50d at the front, which is located adjacent to the inner end of the planarizing face 50b (near the groove 21). The die 50 is substantially broader in the radial direction compared to the deforming die 40 for the second applied compound layer according to figure 6b. This process step is identical to that of figure 5b.

Due to the additional deformation of the first compound layer A an enhanced adhesion in the circumferential groove, in particular in the area 21a, is obtained. Therefore, this section of the compound will be freed from possibly formed bubbles or the number of existing bubbles is significantly reduced, which also contributes to an enhanced adhesion.

Due to the die induced deformation and the increased uniformity of the downwardly facing (in reality: upwardly facing) surface also the connection and the overlap according to figure 6b, which is based on the here presented end portion of the axial compound layer B, may be provided with an enhanced adhesion to the first sealing means A and adhere more efficiently by the pressure effect of the die 40.

The lining technique as a first process step is complemented by die pressure application process as is previously described for the second applied layer. The

advantages achieved were described. The usage of the second die 50 may be used in correspondingly modified configuration for such processes, in which the radially inner compound A is not applied first but is applied after the radially outer lying compound layer B and is then formed. Such an embodiment is described later with reference to figures 10 and 12.

Compared to the pairs of figures 6 the figures 8a and 8b are configured differently in the same manner as the difference of the pair of figures 7 with respect to the pair of figures 5. The form or shape of the circumferential groove 20 is configured in a flat manner compared to the wedge shape of figures 6. Additionally, in figure 8a the stripe area a2 is illustrated in addition to the further deformation die 50, wherein the superior adhesion of the stripe area and the reduced amount of bubbles is obtained. The transition between the planarization stripe 50b applying pressure to the front side and the inner stripe 50d offset in the backward direction is located in the area 3a at the interface between the cap level and the circumferential groove 20.

Also the process according to the pair of figures 10 is based on a doubled die induced deformation.

In these figures 10a, 10b the process according to the pairs of figures 9 is used with the same initial die 40 during the application of the radially outer compound, which in the present case is applied first in the compound layer B and which has a substantially cylindrical configuration. A process step follows corresponding to figure 9b and which is not explicitly illustrated in figures 10. After this process step the process step illustrated in figure 10b is performed for a further planarization of the compound layer located radially more inwardly, which is as layer A provided with the front side 51b of a further die 51 at a lower face in a more even manner so as to have a reduced axial extension. The axial extension (thickness) is reduced at the outside in order to configure more uniformly at least the lower surface in the direction of a substantially horizontal plane. For this purpose, a recess 51c at the radially outer side of the die 51 is used such at this recess does no longer affect the previously formed outer compound layer B and at most touches the same without applying a significant pressure. The resulting overlap area is relative to figure 9b with its lower side more even and has a superior adhesion in the transition area between the two compound layers A and B, which is evident by the different colours and which is lightly wavy in the cross section and which extends along the circumference. A radially outer most edge line or borderline of the compound A located radially more inwardly as also made more uniform by the outer edge 51d of the die mould 51. Despite of the pressure application the radially inner edge 51e in the transition area 3a between the

two areas 1, 2 provides for non-displacement of the post-planarized compound A into area 1.

By means of the post-planarization according to figure 10b additionally a tail formation may be avoided such that blurring of the radially outer borderline (at 51d with respect to compound A) of the compound secondly applied may be avoided or may be reversed. During the post-planarization the first compound A is still flowable so as to be resilient upon application of pressure and to reduced bubbles as well as improve adhesion.

Also the process of providing enhanced uniformity of the radially outer borderline of the radially inner compound A is shown in the pair of figures 12, that is along the line a1 in figure 2b. Starting from the process according to the pair of figures 11 the further die 51 is used to planarize the compound layer A, whereby at least three effects are achieved previously already discussed. A superior adhesion in the overlap area a3 as a wave-like line in cross section extending along the circumference and in which also bubbles are removed when a pressure load is created by the die 51. In the same area also the adhesion between the two compound layers A and B is improved. The avoidance of a blurring along the circumferential line a1 is a further effect of the planarizing with the die 51. Also in the pair of figures 12a, 12b the process step of figure 11b is intermittently to be performed to apply the compound to the layer A and to form and displace the same by a rotation. The result obtained is the same as in figure 11b, which is post-planarized according to figure 12b on the basis of the front face 51b of the die 51.

The radial outer recess 51c of the die 51 is significantly more exposed compared to figure 10b without contacting the substantially cylindrical compound layer B during the post-deformation.

The pair of figures 15 is based on the manufacturing process of the pair of figures 16. Also in this case a post-deformation in the sense of a planarization with a second die 51 is provided. Again figure 16b is to be added as an intermediate step between the process steps of figures 15a and 15b. Moreover, the manufacturing process according to figures 16 may also be applied to the embodiment of figures 15. The groove 22 is configured as a combined groove corresponding to the description of the figure 16a. The resulting effects of an improved adhesion in the overlap area a3 and the avoidance of a tail formation along the borderline a1 of the radially inner compound A are again achieved by the die induced post-deformation. The layer A is more even

and in axial direction more uniform compared to the example of figure 16b in which an additional planarization step is not used.

A separate description of a process should be provided with reference to figures 13a to 14b.

The shape of the circumferential groove 22 is in a way as is explained with reference to figure 16a. A combined groove 22 is provided which at least hinders the pre-form applied by the lining technique in its deformation by rotation with respect to its further displacement. Depending on the amount of applied compound A, depending on the rotation speed and the depth of the fin 20a a more or less pronounced barrier effect is obtained, which, however, needs not to be a complete one, as is shown in figure 13a. In the circumferential channel 20 a residual volume remains for the reception of the compound to be applied later so at a significant barrier effect is evident, yet the circumferential fin 20a does not block the radial outward displacement of the compound A entirely. A too pronounced radial expansion of the first compound during the radial replacement caused by centrifugal force (from the rotation according to figure 2b) is hindered.

Figure 13b illustrates a subsequent process step or the stage of the end of several intermediate process steps according to figures 1a, 1b and an application of the die 40, which causes the initial deformation of the compound B in the substantially cylindrical layer. It is evident that the interface between the two compound layers A, B in the overlap area as a different curvature compared to for example the embodiment according to figure 15b, for an otherwise identical combined groove 22.

The axial thickness of the inner compound layer A tapers towards the bottom of the groove 20 at figure 13b. In figure 15b the axial thickness of the compound layer A tapers towards the exposed sealing face and the borderline a1.

Each of the die 50 has a body section 50a and is axially sectioned and is illustrated as a partial view. Moreover, they are configured in the same way as die with a drive assembly and a support. The same holds true for the die 51 having a body section 51a and a planarizing surface 51b.

The figures 14a and 14b in turn have differently formed overlap zones of the two compound layers according to figure 14b, which here substantially extends in an oblique manner including a conical surface, which passes the inner smaller circumferential 20a and which has substantially 45° as an angle with respect to the

horizontal direction. It results from the forming effect of a channel 55 of the first deforming die 52 according to figure 14a, the front edge fin 54 of which is configured such that it extends with its front radially outside the smaller circumferential fin 20a and to the bottom of the main groove 20 and provides for a blocking effect for the further radial displacement of the firstly applied compound layer A. It is applied as is illustrated in figure 2a, does, however, not necessarily need to be deformed by rotation, but may be.

An additional pressure driven post-deformation after a rotation based displacement forms the lower surface of this firstly applied compound layer A in a substantially flat manner, as is defined by the shape of the bottom of the recess 55. In the area a3 a line-like improved adhesion is obtained. Also bubbles that may have formed are reduced by the additional deformation step with the die 52a. This die 52a has a body section 52a opposite to the circumferential recess 55, a continuously extending inner wall face 56 and an outer recess 53 which is located opposite to the apron 4 during the illustrated engagement state of the axial pressure application.

The subsequently applied second compound layer B according to figure 14b corresponds to the application process of figures 1a, 1b during a displacement and deformation of the compound in the illustrated context and adjacent to the inclined surface of the first compound layer A as it has left the recess 55 with its edge fin 54 after removal of the die 52.

The deforming die 40 corresponds to that of figure 13b or also approximately the die of figures 7b, 8b with a somewhat broader front side between the circumferential edges 41, 43.

Figure 18 depicts an enlarged view from the above-described figure 13b. Here, the combined groove 22 is illustrated more clearly as also the upwardly tapering thickness of the radially inner compound layer A, adjacent to which the compound layer B overlapping in the intermediate area D is located as an interface.

During the engagement of the die 40 in the area of its front side 42' and its outer circumferential edge 41b a sharp tapering extending inwardly of the compound layer B is formed. This tip ends at the downwardly protruding ring protrusion with its highest position 42', which defines a borderline in a line-like manner, beyond which compound B may not extend during its deformation and displacement, that is, it is blocked with respect its radial inward motion. With respect to a corresponding application and effect

also the fin-like configuration 42 according to figure 11a was configured such that a barrier for an inward deformation of the compound layer B is obtained.

The front face of the die 40 being substantially wedge-shaped in the cross section includes with its highest line 42' this barrier zone contacting the radially inner compound A. The radially inner edge line 43 of the die 40 is then not required for blocking the compound flow.